PATENT SPECIFICATION

617,431

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COMPLETE SPECIFICATION

Improvements in Materials for the Selective Transmission of Light

I, ELWYN GEORGE BERRIEN RILEY, a Citizen of the United States of America, of Pinehurst, County of Moore, North Carolina, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement: —

This invention relates to materials for the selective transmission of light and is intended more especially for packaging and protecting foods, plants, and other product which are subject to deterioration by chemical changes due to the action of light rays thereon.

The packaging of plant products in containers made of material which transmits light having a wave length above 4900 Angstrom units, (in some cases between 5000 and 65000 Angstrom units) and excludes light having a wave length below 4900 Angstrom units has previously been suggested for curing and preserving such plant products.

Also for the purpose of inhibiting undesired photo-chemical action on commodities such as rubber products, plant products, comestibles, oils, fats and such like products, it has previously been proposed in specification No. 560,714, to shield such commodities by means of a colour screen which is opaque to light having wave lengths between 6300 and 6700 Angstrom units, and below 4900 Angstrom units, but which transmits substantially all other light and may comprise materials normally translucent or transparent to visible light, such as glass, glassine, synthetic plastics, gelatine, casein, synthetic resins, non-fibrous cellulose materials such as regenerated cellulose, and cellulose derivatives as cellulose esters, and ethers and cellulose oxy-ethers, or composite materials containing two or more of the above mentioned substances, namely, impregnated and/or coated materials such as lacquered glass, or lacquered regenerated cellulose, as well as laminated products comprising laminated glass and paper.

Furthermore for the preservation of oils, fats, waxes and substances containing them, including foodstuffs, it has previously been proposed to screen such products, as by wrapping material, or a container therefor, dyed to exclude light having a wave length between 2900 and 4700 Angstrom units, and to permit not less than about 50% total transmission in the visible region from 4900 to 6900 Angstrom units, the basic sheet material being glass, synthetic plastics, gelatine, cellulose bodies or the like which are dye impregnated or coated, or formed as laminated material.

The material for the selective transmission of light and intended for use as protective material, according to the present invention, comprises a body which is made substantially opaque to light having wave lengths from 2000 to 5000 and from 6200 to 7500 Angstrom units and which transmits light having wave lengths from 5000 to 6200 and above 7500 Angstrom units.

The term "light" as used herein refers not only to visible light (3800 to 7200 A°) but also includes wave lengths of solar and artificial light of wave lengths between 2000 and 8000 A°.

By "substantially opaque" or "substantially absorbent" I mean that it will not transmit more than five (5) per cent. of those wave lengths it is intended to absorb.

The material may be formed from a basic body, such as paper stock which normally transmits light rays of some or all wave lengths from 2000 to 7500 Angstrom units. Thus a coating or impregnant may be applied to transparent or semi-transparent material, so that the finished material will transmit selected beneficial wave lengths of light from 5000 to 6200 Angstrom units and above 7500 Angstrom units while excluding or absorbing wave lengths of light from 2000 to 5000 and 6200 to 7500 Angstrom units.

These selected beneficial wave lengths I find are particularly effective in promoting a desirable photochemical action on many commodities. For best results with many commodities, I prefer that the percentage of transmission of wave lengths of 8000 A° be not more than fifty per cent. of the transmitted wave lengths of 5400 to 5800 A°.

The coated or impregnated normally transparent or semi-transparent material of the present invention may be employed as a panel, screen, textile material package, container or wrapping, suitable for the protection of material in transit in the higher altitudes, for example air transport, where ultra violet light of very low wave lengths is encountered, as well as the protection of human eyes in the presence of the shorter wave lengths of ultra violet light.

The material of the invention, moreover, will not be active in promoting the growth of mold and like spores, since I have found from experiment that growth in many molds is activated and promoted by selected bands of light of from 6300 to 7500 Angstrom units, and the material of the invention is opaque to, or absorbent of, wave lengths of light between about 6300 A° and 7500 A°.

Instead of resorting to impregnation or coating of a transparent or semi-transparent base to form the material of the invention, said material may be formed as a laminated product having the required spectral characteristics by forming the light absorbing or excluding component as a separate layer for application to paper, glassine, glass sheets, textiles, natural and synthetic rubber sheetings and transparent plastic materials and the like.

The invention will be more readily apparent from the following more detailed description with reference to the accompanying drawing which illustrates a spectrophotometric graph of a material according to the invention, and in which the abscissa indicates the wave lengths of light in Angstrom units and the ordinate the percentage of light transmission through the material.

The material, having the spectral characteristics illustrated by the graph, is one normally permeable to some or substantially all light of wave lengths from 2000 to 8000 A° and which has been rendered substantially opaque to or absorbent of wave lengths of light from 2000 to 5000 and from 6200 to 7500 Angstrom units with an ability to transmit wave lengths of light from 5000 to 6200 A°, and above 7500 A° with a peak transmission between 5400 to 5800 A°.

The infra-red wave lengths above 7500 A° are not so harmful to most perishable merchandise but I prefer that the transmission of light at 8000 A° does not exceed fifty (50) per cent. of that of the selected transmitted wave lengths between 5400 and 5800 A°.

The material of the invention may be a panel, glass optical structure, textile fabric, flexible wrapping of paper, cardboard stock, and the large variety of synthetic plastic materials such as synthetic rubber sheeting, normally transparent regenerated cellulose, or any of the well known wrapping, packaging or structural materials, prepared by incorporating therewith suitable light absorbents of such characteristics as to impart to the material spectrophotometric properties as illustrated in the drawing. The term "synthetic plastic materials" includes the varieties of synthetic resin such as the aceto-butyrate, phenolic, urea, polyvinyl, ethyl cellulose, cellulose-acetate, polystyrene, and polymethyl-methacrylate.

The base of the material, which may be paper, glassine, vegetable parchment, textile fabrics, cellulose derivative, synthetic rubber, glass, synthetic plastic composition or other material wholly or partly permeable to light of wave lengths of from 2000 to 8000 Angstrom units, is combined with a light absorbent material either as an impregnant, coating or ingredient mixed therewith to render said material selectively absorbent of wave lengths of light from 2000 to 5000 Angstrom units and transmissive of wave lengths of light from 5000 to 6200 and above 7500 Angstrom units.

The absorbents are preferably in the form of dyes and may be either water soluble or alcohol soluble, depending upon the nature of the material to be impregnated, coated or otherwise rendered transmissive to the selected wave lengths of light aforesaid.

In the following examples the proportion of the dye or pigment mixture is expressed in parts by weight and the liquids or solvents are expressed in parts by volume.

EXAMPLE I.

One water dispersable dye mixture that is suitable for mixing with raw stock of a paper beater comprises

95 parts of Hansa Yellow (Fast) TRD Paste (No. 84, Schulz "Farbstofftabellin")
5 parts Heliogen Blue (Fast) BWS, (a water dispersable copper phthalocyanine, not dentified by any dye number)

100 parts

The amount of such dye mixture that is to be added to the stock will vary considerably depending upon the nature of the raw stock. For example, considerably less dye mixture is required for unbleached paper stock than for bleached stock and other lighter or more transparent materials.

EXAMPLE II.

A suitable alcohol soluble absorbent or dye mixture comprises

95 parts Metanil Yellow P concentrated (Fast) (CI 138. Colour Index of the Society of Dyers and Colourists).
4.5 parts Brilliant Blue (Fast) 6 CB (CI 658. Colour Index).
0.5 parts Nigrosine SSB. (CI 864. Colour Index)

100 parts in 900 parts (by volume) of ethyl alcohol.

It will be understood that the proportion of the several dyes may be varied slightly, depending upon the use of the material and also that the proportions of dye to the stock will vary considerably, depending upon the nature of the stock to be dyed.

Such dyes may be incorporated and thoroughly mixed in the partly prepared stock, whether glassine, paper, regenerated cellulose, natural or synthetic rubber stock, resins or other synthetic plastic composition, prior to the sheeting or fabrication thereof, to provide a homogeneous material possessing the spectrophotometric characteristics shown in the drawing.

Also, these dyes may be incorporated in the layers or laminations or adhesives employed for laminating sheets of paper, glassine, regenerated cellulose and the like where it is desired to produce a laminated flexible wrapping or packaging material for laminating sheets of transparent plastic for aircraft and like windows and for laminating sheets or pieces of glass for anti-glare windshield sections, and sun and light therapeutic eye shields.

EXAMPLE III.

A suitable light absorbent coating suitable for application to normally transparent material such as window glass, glass containers, glass and transparent plastic panels, spectacle lenses, transparent thermoplastic sheets, natural and synthetic rubber sheets and articles, regenerated cellulose wrapping paper and textile fabric in sheet or web form may comprise an absorbent in a lacquer or resin vehicle. Such lacquer light-absorbents are preferably alcohol soluble and may comprise a mixture of the following ingredients:

6.68% Super Bickacite 2000, which is an alcohol-soluble pure Phenolic type resin (Beck Kohler Co., Detroit, Mich.)
4.46% Ethyl Cellulose
17.42% Ethyl Alcohol
6.40% Pentyl Acetate
6.40% Butyl Alcohol
58.64% Dye Solutions of Example II.

It will be understood that the amount of the dye solution that can be incorporated in the lacquer vehicle or coating will determine the transmission of the unabsorbed wave lengths of light, and hence the thickness of the coating may vary considerably for different uses.

Referring to the drawing, the dye incorporated material or dye coated material is of such colour density as to absorb all, or at least 95% of the wave lengths of light between 2000 A° and 5000 A°. From 5000 A° the curve rises indicating a transmission of beneficial wave lengths of light from 5000 A° to 6200 A°. The transmission of these beneficial wave lengths at the peak, namely between 5400 and 5800 should be high as compared to the absorbed wave lengths and with substantially complete absorption of red rays from 6300 to 7500 A°, this being the upper limit of visible light. The beneficial effect of the transmitted wave lengths from 5000 to 6200 A° is enhanced by the accompanying transmission of wave lengths of light from 7500 to 8000 A°, but preferably the transmission of infra-red rays of 8000 A° should not exceed 50 per cent. of that of the transmitted beneficial rays of wave lengths from 5400 to 5800 A°.

According to one embodiment of the invention, the material may be a flexible wrapping or packaging material for foodstuffs and other commodities affected by light. For such use the material may comprise a single thickness or a laminated sheet of paper, glassine, regenerated cellulose, synthetic rubber hydrohalide sheeting, or textile fabric, and the light absorbent may be incorporated as an ingredient mixed with the raw or partly prepared stock, as an impregnant or as a coating applied to one or both sides of the material, or as a layer or lamination between laminated sheets thereof.

According to another embodiment of the invention, structural panels of normally transparent plastic or glass, spectacle lenses, synthetic plastic and glass containers and receptacles may be coated on one or both sides with the light absorbent containing lacquer as above described.

Alternatively, when it is desired that such structures be formed of laminated materials, the layers may form the absorbent carrier as above described. Such materials are particularly useful for windows, glass panels for food showcases, sun glasses, light bulbs, beverage and food containers and the like where the exclusion of certain rays and the transmission of selected other rays according to the invention is desirable.

According to a further embodiment of the invention, textile fabric and particularly woven cloth, may be rendered selectively absorbent and transmissive of wave lengths of light as herein set forth by impregnating or coating the fabric with absorbents above described in Examples II and III. Such absorbents may be incorporated in a resinous or plastic carrier or vehicle which is applied to one or both sides of the textile fabrics, as may be desired. Such fabrics are especially useful in the manufacture of garments of various kinds for persons, susceptible to burning by ultra violet light, for use as packaging materials, tents and the like.

Providing for substantial opaqueness to, or absorption of, wave lengths of light from 2000 A° to 5000 A° is of great importance where the shorter wave lengths of ultra violet light, estimated at approximately 2000 A° and substantially below the range of visible light, are encountered. For example, in modern air transport lower wave lengths of the ultra violet are encountered than nearer the earth's surface. For such use the commodity packaging and wrapping materials as well as the glass and plastic panels of the invention, which may be used as windows for aircraft, are particularly desirable in protecting the cargo commodities as well as the passengers and personnel from the harmful effects of those lower wave lengths of ultra violet light.

Furthermore, because of its ability to absorb substantially all wave lengths of light from 2000 to 5000 A°, the material of the invention is of special value for use as visors and eye shields for welders and patients subjected to the treatment by ultra violet ray lamps, many of which lamps, as well as the welders' carbon arc, produce wave lengths of ultra violet light as low as 2000 A°.

The feature of the invention in providing for transmission of selected beneficial wave lengths of light between 5000 and 6200 A° is of great importance in connection with the packaging of foodstuffs and like commodities. The effect of these beneficial wave lengths accompanied by a limited band of infra-red wave lengths from 7500 to 8000 A° has the effect of increasing the sweetness and flavour of many fruits and vegetables, in some cases, to a greater extent than is found in tree or vine ripened fruit of the same species. For example, many comparative tests have been made of peaches, cantaloupe, grapefruit, oranges, lemons, tomatoes and similar commodities, ordinary wrapped specimens, tree or vine ripened specimens and specimens encased in wrapping materials of the present invention, and in all cases the specimens wrapped in the materials of the invention possess a marked increase in sweetness and flavour. Without intending to be limited to any theory of photochemical reaction there appears to be substantial evidence that the selected transmitted wave lengths of light have a desirable photochemical reaction in the constituents of the fruit to increase the sugar content thereof, while the absorption of other wave lengths of light retards the formation of starches. Whatever the theory, a distinctly beneficial effect is noticeable when foodstuffs are packaged in materials of the present invention.

A still further advantage of the material of the invention resides in substantially complete absorption of wave lengths of light from 6000 to 7500 A°, which wave lengths of light promote the growth of mold spores, particulars molds of the *penicillium* and *aspergillus* genera. Hence, the absorption of these wave lengths of light by the materials of the present invention provide for more complete protection of perishable and mold-forming commodities which is particularly advantageous in the packaging of many foodstuffs, for example, peaches, citrus fruits, cheeses, meats and the like.

Furthermore, the material of the invention is particularly advantageous in protecting many materials that are disintegrated by the action of light. For example, certain synthetic rubber packaging materials, such as synthetic rubber hydrohalide compositions, are frequently decomposed by strong light to such extent that they may impart an unfavorable flavour and odour to the products enclosed therein. Such decomposition is prevented by incorporating the light absorbents herein described in the packaging material or by coating the material with a lacquer containing the absorbents herein described.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A material for the selective transmission of light, and intended for use as

a protective material, comprising a body which is made substantially opaque to light having wave lengths from 2000 to 5000 and from 6200 to 7500 Angstrom units, and which transmits light having wave lengths from 5000 to 6200 and above 7500 Angstrom units.

2. A material for the selective transmission of light, for use as a protective material, comprising a transparent or semi-transparent basic body which is normally permeable to at least a portion of the wave lengths of light from 2000 to 8000 Angstrom units, and which has applied thereto a light absorbent medium to render said material substantially opaque to wave lengths of light from 2000 to 5000 Angstrom units and from 6200 to 7500 Angstrom units, whilst permitting transmission of light of wave lengths from 5000 to 6200 Angstrom units and above 7500 Angstrom units.

3. A material for the selective transmission of light according to claim 1 or 2, having a peak transmission of wave length of light between 5400 and 5800 Angstrom units.

4. A material for the selected transmission of light according to claim 1, 2 or 3, wherein the transmission of the wave length of light of 8000 Angstrom units is approximately 50 per cent. of the peak transmission of wave lengths lying between 5000 and 6200 Angstrom units.

5. A material for the selected transmission of light according to claim 2, wherein the basic body is impregnated with a light absorbent to impart thereto the spectral transmission characteristics herein set forth.

6. A material for the selected transmission of light according to claim 2, wherein the basic body is coated with a light absorbent to impart thereto the spectral transmission characteristics herein set forth.

7. A material for the selected transmission of light according to claim 2, wherein said material is a laminated material having a light absorbent layer or lamination to impart thereto the spectral transmission characteristics herein set forth.

8. A material for the selected transmission of light according to claim 2 wherein the basic body is a woven textile.

Dated this 1st day of July, 1946.

MATHYS & SQUIRE,
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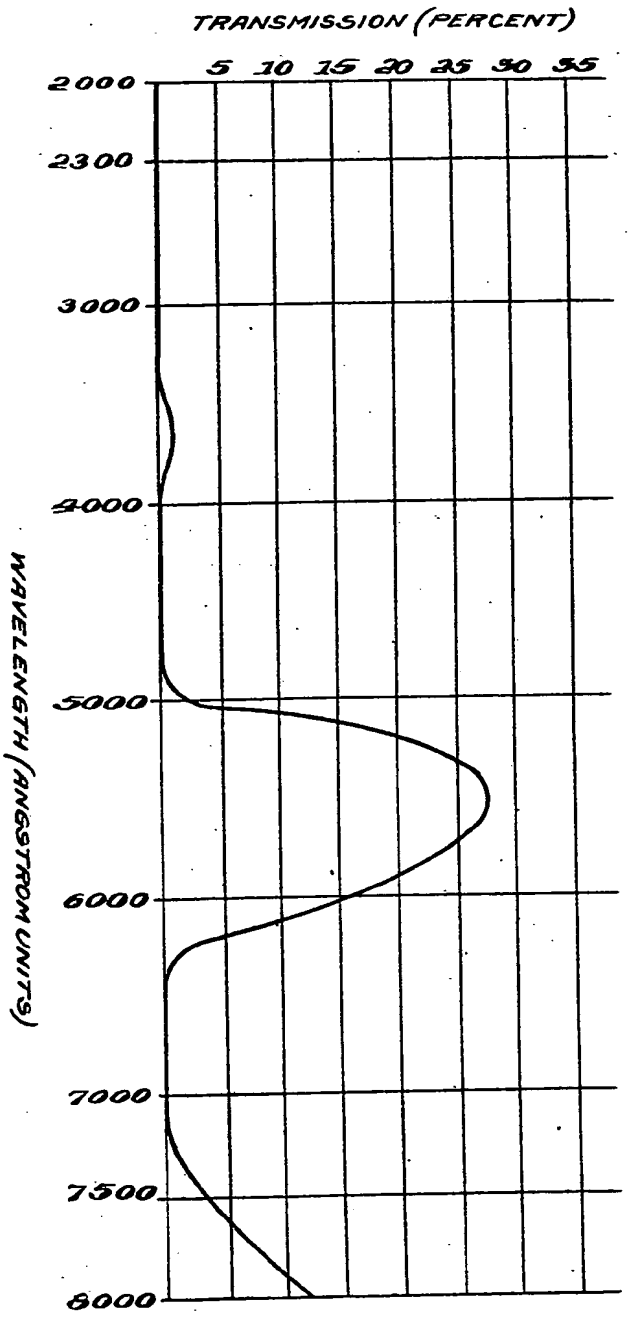

[This Drawing is a reproduction of the Original on a reduced scale.]